DRAPER

Chemical Study of Specially Prepard Foods

Chemistry
B. A.

1902

UNIVERSITY
OF

Learning and Labor.
LIBRARY
OF THE
University of Illinois.
CLASS. BOOK. VOLUME.
1902 D79
Accession No.

A Chemical Study of Specially Prepared Foods

BY

EDWIN LYON DRAPER

THESIS

FOR THE

DEGREE OF BACHELOR OF SCIENCE

IN CHEMISTRY

COLLEGE OF SCIENCE

UNIVERSITY OF ILLINOIS

1902

Digitized by the Internet Archive
in 2013

http://archive.org/details/chemicalstudyofs00drap

1902
D79

UNIVERSITY OF ILLINOIS

May 31st 1902

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Edwin B. Drafer

ENTITLED A Chemical Study of Certain Prepared Foods. (Thesis)

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF Bachelor of Arts in Chemistry, Arthur W. Palmer

HEAD OF DEPARTMENT OF Chemistry

55407

UIUC

A Chemical Study of Specially

Prepared Foods.

Definition of Food :--A food is [illegible] which is absorbed by the body, and utilized either in generating heat or in building up tissue.

Food constituents are usually classified as follows: (1) Water; (2) Inorganic salts; (3) Proteids or protein containing bodies; (4) Albuminoides, a group of bodies resembling proteids; (5) Carbohydrates; (6) Fats.

Water and salts are not commonly considered as nutrients, but as they are both absolutely necessary for the existence of life, it seems as if they should be included. Instances are on record of dogs being kept on a diet free from salt, but none but kitchen dogs which is given no food at all.

Different varieties of proteids are to be found in both animal and vegetable tissues, but their composition is practically the same, and though there are differences in digestibility, physiologically they are supposed to have equal nutritive values. Proteids are the only substances which can build up new protoplasm, and therefore, are of absolute necessity, not merely being the only material for the formation of new protoplasm, they are also extremely valuable as sources of energy to the body.

Albuminoides, commonly found in the form of gelatin, cartilage or tell [illegible] resemble proteids chemically, but they lack the power of building up protoplasm, and although they contain nitrogen, they are usually considered with the non-nitrogenous foods.

In other words, foods of all kinds carry the surround in the body. In the first place, it supplies a fuel which burns in the body, supplying heat for keeping the body temperature up, and the energy which is necessary for muscular and mental work. In the second place, foods supplies the body with material for building and repairing its tissues and fluids.

Carbohydrates contain no nitrogen and include starches, sugars, gums, etc. Their value lies in the fact that they are destroyed in the body and a certain amount of energy generated. The energy of muscular work and of the heat of the body comes largely from the oxidation of the carbohydrates. The bulk of an ordinary diet usually consist of this class of foods.

Fats also, contain no nitrogen and include the oils, both animal and vegetable, that form a common part of our ordinary diet. Fats, similar to the carbohydrates, liberate energy in the body, but are not so easily handled in quantity in the body, and are therefore, considered as a valuable article of food as compared with carbohydrates.

The vegetable foods contain a very much smaller percentage of carbohydrate than do the animal foods as is shown by tables of analyses of various kinds of vegetable foods in König's "Die menschlichen Nahrungs und Genussmittel", Vol. No. 1889.

Under ordinary conditions the body is able to digest the principle food constituents, converting them into soluble forms so that they can be absorbed into the circulation. The carbohydrates are converted into sugars, then broken down by a process called fermentation into lactic acid and finally into carbonic acid and water.

stock. But in case of sickness the problem becomes difficult and sometimes perplexing with the mother, until milk foods which have been specially prepared are taken.

This being the case, there is found upon the market today, a large number of specially prepared foods.

Many of these foods are "predigested", that is, an attempt has been made to convert a certain amount into soluble substances, and so, to a certain extent relieve the stomach and intestines of this work. In order to do this the ray foods are subjected to treatment with diastatic ferments for a certain of several hours, or they are called on special processes which convert the starch and the other insoluble carbohydrates into a soluble sugars; then they may be dried at low or high temperatures in vacuo, or treated in various ways, each manufacturer having his own special process.

Inasmuch as one of the objects primarily aimed for in preparing these foods is to increase their solubility, it seems that a method of analysis which would include the preparation of a water extract, and a chemical examination of the same, would be the only adequate way of finding out how well the various foods were prepared, how they would.

In analyses previously made, account is a few cases, no examination has been made of the water soluble portion of the food. To this end a method has been devised for making the water extract, and the method thus made has been submitted to the following determinations:--(1) Total solids; (2) Proteid (N×6.25), (3) Sucrose, (4) Ash, this is in addition to the complete analysis of the original sample, in which the following determinations were made:--(1) Moisture; (2) Fat; (3) Proteid (N×6.25); (4) Crude fiber; (5) Other

carbohydrates (by difference); (6) Ash.

In preparing the sample care was taken to get one which would fairly represent the whole. In cases where there was a large jar of material, portions were taken from different parts of the jar. Those foods which were not in a finely divided form, were ground in a steel mill and then passed through a very fine sieve.

The methods used in the analysis of the dry sample were as follows:--

1. Moisture.

A piece of hardened filter paper was fastened over the end of a glass extraction tube by a piece of fine iron wire. The tube was then dried from one to two hours in a glycerine oven, and next weighed in a telescopic weighing tube and a sample of from 1.5-2 gr. was weighed off. The substance was then dried, lying in a horizontal position, in a glycerine oven at a temperature of 105°C. for several hours, and then weighed, replaced in the oven and dried for another hour. This process was repeated until weight was constant. The loss in weight was due to the water in the sample.

2. Fat.

The extraction tube with the sample left from the moisture determination was placed in a larger extraction tube, the bottom of which was covered by two thicknesses of paper, the inner of quantitive and the outer of hardened filter paper. They were then extracted by dry ether for 12-36 hours, catching the fat in weighed Erlenmeyer flasks, from which the ether was afterward driven off and then weighed, the increase in the weight of the flasks being the fat.

3. Protein(Total Nx6.25).

From 1 gr. to 2 gr. of the substance was weighed in a

weighed into a 500 c.c. Kjeldahl flask. 25 c.c. conc. H_2SO_4 and 0.65 gr. HgO were added and the mixture digested until the solution was colorless, then ammonium MnO_4 was added to finish the oxidation. After the flask had partially cooled 200 c.c. of N free distilled water was added with 50 c.c. of saturated NaOH solution + K_2S (40 gr. to the liter) and several pieces of granulated zinc. Then the flask was attached to a block tin condenser and the ammonia distilled into a 750 c.c. Erlenmeyer flask to which the measured amount of standard acid had been added. After 175 c.c. - 200 c.c. of the liquid had distilled over, a half a c.c. of Lacmoid indicator was added and the excess of acid titrated by standard NaOH solution, then the calculation for total nitrogen was made and this multiplied by 6.25 to get percentage of protein, because there is approximately 16.25% nitrogen in protein.

4. Crude Fiber.

The fat free sample was placed in a 500 c.c. flask, 200 c.c. of 1.25% solution of H_2SO_4 were added and the mixture boiled. The flask was fitted with a reflux condenser, for 30 minutes. This was filtered immediately upon a Gooch crucible and washed with boiling water till free of acid. The filter was rinsed out into boiling water and the residues washed through the filter. The filter with the residue was placed back in the original flask and 200 c.c. of 1.25% solution of sodium hydrate was added and boiled for 30 minutes, filtered hot and washed with boiling water till free from alkali. The crucible and contents were dried in an oven for several hours, at a temperature of 104°C., and weighed. It was then ignited at a dull red heat till the filter was white, and weighed again, the loss of weight being the crude fiber.

D. Ash.

A sample of from 1 gr. to 2 gr. was weighed out in a platinum platinum dish or crucible and ignited at a dull red heat until the organic matter was burned off, then at red welding heat. The dish or crucible is cooled in the desiccator and weighed as Ash.

Preparation of Water Extract.

In order to extract the water soluble constituents of the soil, the method first tried was to weigh off samples of from 5 gr. to 10 gr. in 500 c.c. beakers and to add water, allowing the soil to stand for an hour with frequent stirring and then decanting off the clear liquid and again treating with water. It was, however, found impossible to accomplish the purpose in this way because of the extreme slowness with which the decanted liquid would pass through the filter, this causing the sample to spoil before the extraction was any more than complete. The following method was devised and used:--

A sample of from 10 gr. to 12 gr. was weighed off into a 500 c.c. glass-stoppered graduated cylinder and water added to the 500 mark. These were shaken at intervals of half an hour for several hours and were allowed to rest in as near a horizontal position as possible without danger of losing any through the stopper. The cylinder was allowed to stand over night on its side and in the morning was once more shaken and stood up and to settle. After settling sufficiently the liquid was filtered through a paper filter and a small crystal of thymol added to the filtrate to keep it from decomposing.

For each determination in the analysis of the soil extract, 100 c.c. of this solution was used. The methods for making the water analysis were

1. Total Solids.

100 c.c. of the extract was transferred to a weighed platinum dish, the evaporated to dryness over the water bath. It was then placed in the air-bath oven at a temperature of 105°C. for

mixed and allowed, repeating the boiling process as before, until the reagent was decolorized.

5. Proteins(Nx 6.25)

100 c.c. of the solution were placed in a Kjeldahl flask and the total nitrogen determined by the method described.

6. Sucrose.

100 c.c. of extract were mixed with 200 c.c. distilled water, 10 c.c. conc. HCl added and the flask placed in a boiling water bath so that the contents of the flask reached a temperature of from 67° to 70° in three or four minutes, which temperature was maintained in the flask for exactly five minutes. The flask was then cooled rapidly and the solution, after neutralizing with Na_2CO_3, was made up to 200 c.c. The sucrose was then determined in this solution by the following procedure:--50 c.c. of Allihn's copper sulphate solution and 50 c.c. of Allihn's alkaline tartrate solution with 50 c.c. of water were placed in a 250 c.c. casserole, and heated to boiling. 50 c.c. of the solution to be examined were added to this and the mixture boiled for two minutes, and filtered through asbestos filter paper, care being taken to wash the filtrate after, allowing it to stand over night to see if any of the copper oxide would settle out, and if so, it was collected again. The precipitate was washed with boiling water until the washings were no longer alkaline. Then the filter paper and contents were transferred to a weighed crucible, dried carefully over an Arnold regulator and then ignited strongly for fifteen minutes, cooled in dessicator and weighed.

One gram of copper oxide is equivalent to .798 gram of metallic copper. From the amount of metallic copper calculated

in Wiley's, Principle and Practice of Agricultural Analysis, Vol. III, page 100.

A. Ash.

The residue from the loss on ignition determination was ignited and weighed, and its weight at the ash being the weight of the ash.

The samples were obtained from the manufacturers direct, and with them advertising and descriptive literature. A description of the six foods which were analyzed is as follows:

1. Malta-Vita.

This preparation is made by the Battle Creek Pure Food Co., of Battle Creek, Mich. The package describes it as a "pure predigested and thoroughly cooked food". The method of its preparation as given in a circular is as follows:- The grain is cooked for two hours at a high temperature and under a heavy steam pressure,

it is then thoroughly malted by a secret process, and reduced to starch in soluble sugars. It is then baked at a very low temperature and powder. It contains proteids while not. Malt-Vita is the only food prepared by this company.

2. Malt Breakfast Food.

This food is made by the Malted Cereal Co., of Burlington, Vt. A circular says of it "The malt used in this food reduces the starch of the wheat soluble. It is made of pure fresh malt and the choicest wheat". The method of preparation was not given.

3. Maltex Bread Flour.

Maltex Bread Flour is prepared by the same company as is number 2. It is said to be the first time malt has been combined with wheat flour. This flour is to be used in the same way as ordinary flour in making bread and cooking in general. The method of preparation was not given.

4. Horlick's Malted Milk (powdered).

This compound is prepared by Horlick's Malted Milk Co. of Racine, Wis. It is composed of fresh pasteurized cow's milk reduced to dryness at reduced pressure and at a low temperature, and of an extract of selected wheat and barley malt. The starch of the grain is converted into soluble dextrin and maltose, and casein of the milk is so acted upon by the plant pepsin, which is developed by a special malting process, that it does not coagulate in the stomach as in the case of raw milk. It is claimed that life can be sustained entirely by this food. It is especially recommended for fevers →

[illegible] [illegible]

[illegible] [illegible]

[illegible] [illegible]

the flask and some pieces of [illegible] and [illegible] at 40°C. for twelve hours. The digesta are then filtered and the solid residue dried in order to test their viability, and recovered with the latter. Some difficulty was experienced in getting all of the solid particles out of the flask, and this was overcome by washing out with some triple H_2SO_4 (1cc. to the liter) (a portion of the acid) and adding these washings to the filtrate (after neutralization). The filter paper with all the residue was then placed in the flask and the digestion was continued for the purpose of solution of Bismuth and calcium, both of which interfere with the estimation of digestibility.

All the determinations were run in duplicate with the exception of the artificial digestions, which were run in triplicates, to insure thoroughly accurate work.

Having run out of a small lot of Gruber, Parke's Malt and Milk Lunch Tablets, these flavored with chocolate were used in the artificial digestion experiments.

The value of the specially prepared foods in disease depends upon the ease with which they can be digested in the stomach and intestines, so that the digestive processes of digestion seem worthy of consideration. In a purely practical standpoint, the value of the food to the body cannot be ignored but, on account of the limited time and difficulty of manipulation, experimental digestion of foods has not been tried. The processes of natural digestion are given below, being taken principally from the "American Text-book of Physiology" with a few additions from lectures given by Dr. C. F. Hemp, in the major course of physiology given in the spring of 1911.

By digestion is meant the processes which take place in the body by which food is converted into a soluble form, so that it may be absorbed and assimilated. Food consists in general of

[illegible] digestion [illegible].

An enzyme or unorganized ferment is a substance, [illegible], which is found in living protoplasm. [illegible], composed of complex organic substances and certain elements, their exact [illegible] action being unknown, because of the difficulty of obtaining them in pure form. The chemical problem is very [illegible], and are classified according to [illegible] physiologic, as follows:

1. Proteid [illegible] or those acting upon proteids. As an example of this group, in the body we have pepsin in the gastric juice and trypsin in the pancreatic juice.

2. Amylolytic enzymes, or those acting upon starches. As an example of this group we have ptyalin in the saliva, and amylopsin in the pancreatic juice. There is also a ferment in the liver capable of converting glycogen into sugar.

3. Fat splitting enzymes are those which act upon the neutral fats, the best known example being steapsin.

4. Sugar splitting enzymes are those which have the power of converting the double sugars into the simple. Two enzymes of this character are found in the small intestine, one acting on cane sugar and one on maltose. The one acting on cane sugar is invertin or invertase, and the one acting on maltose is maltase.

5. Coagulating enzymes are those acting upon soluble proteids, precipitating them in an insoluble form. The example in the body is the rennin of the gastric juice which curdles milk.

The action of enzymes, with the exception of the coagulating enzymes, is incomplete, that is to say, given solutions will not completely destroy the substance upon which they act, and except for very small quantities the amount of change caused by [illegible]

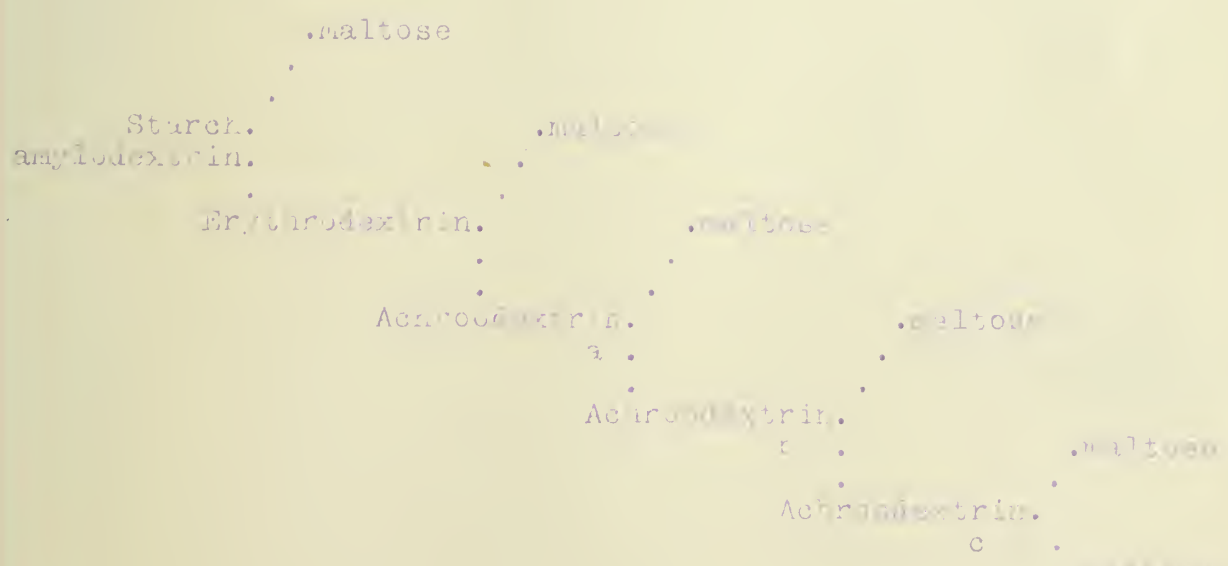
of the amount of enzyme present. From this fact it was formerly supposed that enzymes were not used up or were not permanently altered by the reactions they cause. This belief is practically correct, but it has been found that a solution of enzyme cannot be used over and over again indefinitely.

It is generally believed now that the action of many of the enzymes, especially the digestive enzymes is that of hydration agents, and produces its effect by what is known as hydrolysis.

Salivary Digestion.

The first enzyme with which the food comes in contact is the ptyalin in the saliva, which is secreted [illegible] mouth. As was [illegible] ptyalin is an [illegible] converts the starches into soluble form such as sugars. Its action has been found to consist of a series of hydrolytic cleavages which split up the starch molecules, the exact products of the reaction depending upon the stage at which the action is interrupted. The saliva has normally an alkaline reaction and ptyalin is not active in an acid medium.

The different steps in the reaction may be shown by the following scheme, proposed by [illegible] (Zeitschrift für physiologische Chemie, 1895. page 232).



It must be stated that the ptyalin in the saliva does not convert the starch as far as the above scheme shows, for the reason that the starch comes in contact with the ptyalin only a short time before the food reaches the stomach, the contents of which are acid and which, therefore, stop the action of the ptyalin, but the amylolytic enzyme in the pancreatic juice helps on the action where the ptyalin stops and carries it through.

Gastric digestion.

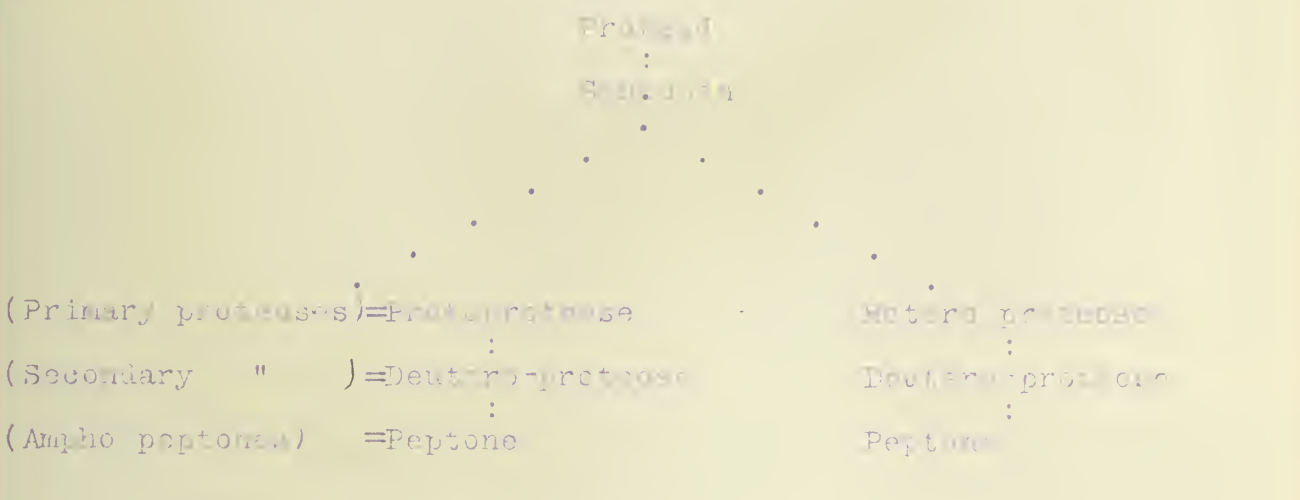
When the food reaches the stomach it is followed by the secretion of the gastric glands which are found in the gastric juice. This juice has an acid reaction caused by free hydrochloric acid, and is the only secretion of free acid, combined or free acid.

The enzyme of the gastric juice is pepsin, a typical proteolytic enzyme. It will act only in acid media so that the peptic digestion in the stomach is the result of a combined action of pepsin and hydrochloric acid.

According to Hamme's theory of peptic digestion the protein is first converted to an acid albumin to which the name of acidalbumin has been given. Syntonin is then acted upon with the formation of several soluble proteids known as primary albumoses or proteoses. These then undergo hydrolytic cleavage with the formation of secondary proteoses or deuteroproteoses. These are then further acted upon, peptones being the result.

Pepsin cannot act on a protein further than the peptone stage although other proteolytic enzymes, trypsin for example, split up a part of the peptone molecule still further. The fact that trypsin acts on only a part of the peptone molecule would seem to show that it is a mixture of at least two closely related peptones, to which the names of anti-peptone and anti-peptone have been given.

A scheme of peptic digestion (Cohnheim, Lehrbuch der Physiologie) is as follows:



The word "peptone" was formerly given to all products of peptic digestion after trypsin had passed the zymogen stage, and commercially the word is still used with this meaning, so that the foods sold as peptones are usually mixtures of proteoses and peptones.

In addition to the pepsin the gastric juice contains another enzyme called rennin which is characterized by its coagulation of milk. The rennin acts upon a soluble protein in the milk known as casein and changes this protein to an insoluble form, which separates out as the curd. The curdling of milk cannot take place except in the presence of lime salts. Casein is a nucleo protein and undergoes hydrolytic cleavage under the action of the rennin, breaking up into two proteid bodies, para-casein and whey protein. The para-casein forms an insoluble compound with calcium salts and is precipitated as the curd; the other protein remains in solution in the whey. Milk is the only food which rennin is known positively to act upon. The conversion into a solid protein (curd) makes the action of the proteolytic enzyme take place more readily.

Gastric juice has no direct action upon the carbohydrates, containing no amylolytic enzyme, yet it is possible that a small portion of carbohydrates pass on into the stomach, for the food is, or should be thoroughly mixed with saliva before it is swallowed, and the action continues until the alkalinity of the saliva destroyed by the hydrochloric acid. There is an amylolytic enzyme found in the stomachs of dogs and cats by Seelig Wroda (Pflügers Archiv fur Physiologie, 1887, page 583) but as yet no such enzyme has been found in the human gastric juice.

There is also no direct action on the fats by the gastric juice, but a mechanical mixture takes place, which facilitates the more rapid digestion of these substances in the intestine.

Intestinal digestion.

As the food passes through the pyloric orifice of the stomach it comes into the small intestine, wherein undergoes very great changes.

The pancreatic juice, the secretion from the pancreas contains a powerful proteolytic enzyme called trypsin, an amylolytic enzyme called amylopsin, and a fat splitting enzyme called steapsin.

Trypsin, as has already been stated is more powerful than pepsin, and acts best in an alkaline medium, although it will work in neutral solution or even solutions which are not too strongly acid.

The products of tryptic digestion are much the same as in the peptic digestion so far as the proteoses and peptones are concerned, but the action differs in several ways. In tryptic digestion the action on solid proteids is erosive, while in the case of peptic digestion the solid swells up and slowly dissolves. In tryptic digestion the hydrolytic cleavages are of a more intense nature, and the solid proteid is converted directly into the deutero-proteoses, without passing through the emulsoid stage as in the peptic digestion. Pepsin has no effect upon the peptones while trypsin acts upon the supposed hemiconstituent splitting it up with the formation of a number of simpler compounds most of which are amino-acids.

The different stages of complete tryptic digestion may be represented in the following scheme. (Taken from Hammarsten, Lehrbuch der physiologischen Chemie, 1907. page 206).

Proteïn
:
Neutro-albumoses
:
Peptone
:
Anti-peptone — Hemi-peptone

Leucin, Tyrosin, Aspartic acid, Nitrogenous bases.

Trypsin produces peptone from proteïn more rapidly than pepsin, and it is probable that most of the proteïn of the food receives its final preparation for absorption in the small intestine under the influence of this enzyme.

Amylopsin and ptyalin are identical in properties, and the changes which amylopsin produces in starches are apparently the same as those produced by ptyalin.

Steapsin or lipase is the third enzyme of the pancreatic juice. It is the fat splitting enzyme and produces saponification of the fat, producing glycerine and a free fatty acid.

Digestion in the large intestine is simply a continuation of that started in the small intestine. The principal function of the large intestine being that of the absorption of the already digested foods, there being almost no absorption taking place in the stomach

at all with the exception of alcohol which is absorbed very rapidly.

The experimental results obtained in this study are given in the following tables.

TABLE NO. 1.

Results of Analysis of Food No. 1.

Malta-Vita.

Determination.	Sample taken	Weight of Substance determined.	Percentage	Average percentage of duplicates
	Grams	Grams	%	%
Moisture	1.0666	.0899	8.43	8.32
	1.1668	.0959	8.21	
Fat	1.0666	.0215	2.02	2.15
	1.1668	.0236	2.01	
Proteid (Nx6.25)	1.2785	(.024774x6.25)	12.091	12.09
	.7224	(.013981 6x6.25)	12.093	
Crude Fiber	1.7797	.0451	2.54	2.53
	1.1442	.0289	2.52	
Other Carbohydrates (by difference)				74.03
Ash	.7701	.0148	1.90	1.88
	.8614	.0161	1.86	

Water Solution of Food No. 1.

Determination.	Sample taken	Weight of Substance determined.	Percentage	Average percentage of duplicate
	Grams	Grams	%	%
Total Solids	8.5041	(.8672x5)	50.95	51.02
	9.0179	(.9213x5)	51.09	
Proteid (Nx6.25)	8.5041	(.01449x6.25)	1.06	1.06
	9.0179	(.015345x6.25)	1.06	
Sucrose	8.5041	(.04895x10)	14.37	14.31
	9.0179	(.0516x10)	14.25	
Ash	.5041	(.0213x5)	1.25	1.50
	9.0179	(.0336x5)	1.75	

Artificial Digestion of Food No. 1.

Malta-Vita.

Sample taken	Proteid in original sample	Proteid in digested residue	Coefficient of Digestibility	Average Coeff. of Digestibility
	Grams	Grams		
3.1525	.38113725	.26243475	68.80	66.90
2.4143	.29166887	.2018845	69.10	
2.7579	.33260471	.20974109	68.80	

TABLE NO. 2.

Results of Analysis of Food No. 2.

Malt Breakfast Food.

Determination.	Sample taken	Weight of Substance determined.	Percentage	Average percentage of duplicate
	Grams	Grams	%	%
Moisture	1.4623	.1182	8.09	8.34
	1.3322	.1113	8.60	
Fat	1.4623	.0298	2.03	1.95
	1.3322	.0250	1.87	
Proteid (Nx6.25)	1.5785	(.033502x6.25)	13.26	13.41
	1.1401	(.0249794x6.25)	13.56	
Crude Fiber	1.5131	.0289	1.89	1.95
	1.7304	.0348	2.01	
Other Carbohydrates (by difference)				72.46
Ash	1.0956	.0199	1.81	1.89
	1.1216	.0221	1.97	

Water Solution of Food No. 2.

Determination	Sample taken	Weight of Substance determined.	Percentage	Average percentage of duplicates
	Grams	Grams	%	%
Total Solids	12.7715	(.4041x5)	15.85	15.89
	13.0291	(.4152x5)	15.93	
Proteids (Nx6.25)	12.7715	(.0204828x6.25)	1.00	.98
	13.0291	(.0202419x6.25)	.97	
Sucrose	12.7715	(.01225x10)	2.40	2.30
	13.0291	(.115x10)	2.20	
Ash	12.7715	(.0185x5)	.724	.72
	13.0291	(.0188x5)	.721	

Artificial Digestion of Food No. 2.

Malt Breakfast Food.

Sample taken	Proteid in original sample	Proteid in digested residue	Coefficient of Digestibility	Average Coeff. of Digestibility
	Grams	Grams		
6.1570	.8256	.7055	85.40	
3.7226	.4992	.4151	83.10	84.20
3.1368	.4206	.3544	84.20	

TABLE NO. 3.

Results of Analysis of Food No. 3.

Maltex Bread Flour.

Determination	Sample taken	Weight of Substance determined	Percentage	Average percentage of duplicates
	Grams	Grams	%	%
Moisture	1.6036	.1444	9.00	9.15
	1.501	.1396	9.30	
Fat	1.6036	.0137	.854	.85
	1.501	.0126	.852	
Proteid (Nx6.25)	.5884	(.0098317x6.25)	10.44	10.40
	.8294	(.0139319x6.25)	10.37	
Crude Fiber	1.6238	.0219	1.35	1.38
	1.2896	.0181	1.41	
Other Carbohydrates (by difference)				77.84
Ash	.2416	.0009	.372	.38
	.8212	.0031	.377	

Water Solution of Food No. 3.

Determination	Sample taken	Weight of Substance determined	Percentage	Average percentages of duplicates
	Grams	Grams	%	%
Total Solids	7.4013	(.2482x5)	16.70	16.44
	10.9508	(.3521x5)	16.08	
Proteid (Nx6.25)	7.4013	(.017245x5x6.25)	7.28	6.89
	10.9508	(.022599x5x6.25)	6.50	
Sucrose	7.4013	(.0236x10)	3.19	3.24
	10.9508	(.0361x10)	3.29	
Ash	7.4013	(.006x5)	.4	.41
	10.9508	(.0092x5)	.42	

Artificial Digestion of Food No. 3.

Maltex Bread Flour.

Sample taken	Proteid in original sample	Proteid in digested residue	Coefficient of Digestibility	Average Coeff. of Digestibility
	Grams	Grams		
1.4993	.1559	.1257	80.60	
3.4686	.3607	.2979	82.30	81.60
3.4973	.3637	.2979	81.90	

TABLE NO. 4.

Results of Analysis of Food No. 4.

Horlick's Malted Milk (powdered).

Determination	Sample taken	Weight of Substance determined	Percentage	Average percentage of duplicates
	Grams	Grams	%	%
Moisture	1.6636	.0408	2.45	2.45
	1.5219	.0375	2.46	
Fat1	1.6638	.0439	2.59	2.61
	1.5219	.0404	2.63	
Proteid (Nx6.25)	2.1831	(.051183x6.25)	14.62	14.56
	1.7445	(.040499x6.25)	14.50	
Ash	.546	.0172	3.14	3.17
	.6834	.022	3.21	

1--Determination incomplete.

Artificial Digestion Experiment of Food No. 4.

Horlick's Malted Milk.

Sample taken	Proteid in original Sample	Proteid in digested residue	Coefficient of Digestibility	Average Coeff. of Digestibility
	Grams	Grams		
3.1119	.4530	.3617	79.80	
1.9712	.2869	.2387	80.40	80.10
2.9207	.4246	.3411	80.30	

TABLE NO. 5.

Results from Analysis of Food No. 5.

Horlick's Malted Milk (lunch tablets)

Determination	Sample taken	Weight of Substance determined	Percentage	Average percentages of duplicates
	Grams	Grams	%	%
Moisture	1.5520	.0085	.55	.54
	1.7024	.0091	.53	
Fat[1]	1.5520	.0612	3.94	3.55
	1.7024	.0537	3.15	
Proteid (Nx6.25)	1.2444	(.029371x6.25)	14.75	15.09
	1.1064	(.0273207x6.25)	15.43	
Ash	1.2684	.0384	3.02	3.04
	1.1396	.0349	3.06	

1--Determination incomplete.

Artificial Digestion Experiment of Food No. 5.

Horlick's Malted Milk.

Sample taken	Proteid in original Sample	Proteid in digested residue	Coefficient of Digestibility	Average Coeff. of Digestibility
	Grams	Grams		
2.2406	.3361	.2657	79.20	
2.1784	.3267	.2611	79.40	80.10
2.7797	.4194	.3429	81.70	

TABLE NO. 6.

Results of Analysis of Food No. 6.

Gluten Biscuit.

Determination	Sample taken	Weight of Substance determined	Percentage	Average percentage of duplicates
	Grams	Grams	%	%
Moisture	.9752	.0742	7.60	7.70
	.8654	.0675	7.80	
Fat	.9752	.0034	.35	.35
	.8654	.0031	.35	
Proteid (Nx6.25)	.5561	(.0229x6.25)	25.71	26.71
	1.3761	(.059935x6.25)	27.71	
Crude Fiber	.9863	.0115	1.18	1.14
	1.2684	.0141	1.11	
Other Carbohydrates (by difference)				63.28
Ash	.5449	.0042	.77	.82
	.5793	.0049	.84	

ater Solution of Food No. 6.

Determination	Sample taken	Weight of Substance determined	Percentage	Average percentages of duplicates
	Grams	Grams	%	%
Total Solids	8.3834	(.0953x5)	5.68	5.74
	6.7741	(.0786x5)	5.80	
Proteid (Nx6.25)	8.3834	(.006112x5x6.25)	2.27	2.20
	6.7741	(.004654x5x6.25)	2.14	
Sucrose	8.3834	(.0237x10)	.56	.59
	6.7741	(.0209x10)	.62	
Ash	8.3834	(.0063x5)	.34	.36
	6.7741	(.0052x5)	.38	

Artificial Digestion Experiment of Food No. 6.

Gluten Biscuit.

Sample taken	Proteid in original Sample	Proteid in digested residue	Coefficient of Digestibility	Average Coeff. of Digestibility
	Grams	Grams		
1.7158	.4572	.2592	56.60	
1.9229	.5136	.3080	59.90	61.03
2.2921	.6122	.4079	66.60	

Discussion of Results.

In discussing the results of this work, it will be well to compare the specially prepared foods analyzed with the average composition of the most important milled products of the common cereals which are used so extensively for the preparation of foods, namely, wheat, oats, and corn.

TABLE NO. 7.

Chemical Composition of Specially Prepared Foods as Compared with Flours.

Food No.	Moisture	Fat	Proteid (Nx6.25)	Crude Fiber	Carbohydrates (by difference)	Ash
	%	%	%	%	%	%
1	8.32	2.15	12.09	2.53	74.08	1.88
2	8.34	1.95	13.41	1.95	72.46	1.89
3	9.15	.85	10.4	1.38	77.84	.38
4	2.45	2.61	14.56			3.17
5	.54	3.55	15.09			3.04
6	7.70	.35	26.71	1.14	63.28	.82
7	11.50	1.00	11.40	.20	75.40	.50
8	12.50	1.90	9.20	1.00	74.40	1.00
9	7.30	7.20	16.10	.90	66.60	1.90

In the above table, the first six foods are those analyzed and studied in connection with this thesis. Food No. 7 is the average of the analyses of one hundred and eleven samples of patent, roller process, wheat flour. Food No. 8 represents the average of analyses of nineteen samples of granular corn meal, while Food No. 9 represents the average results of the analyses of sixteen samples of oat-

meal. The data for these last foods was taken from Bulletin No. 28 (Revised Edition of the U. S. Department of Agriculture, office of Experiment Station).

In examining data given in table No. 7, the following facts are noticed:--

1--None of the foods analyzed in connection with this thesis have as high a percentage of moisture as the wheat flour or granular corn meal, while foods Nos. 1, 2 and 3 have a higher percentage than the oatmeal, Foods Nos. 4 and 5 have a much lower percentage and Food No. 6 is practically the same as the oatmeal in regard to the water constituent.

The percentage of fat in the oatmeal is much higher than in any of the other foods. Food No. 1 has a slightly higher percentage than either Nos. 7 or 8, while No. 2 has the same percentage as No. 8, being somewhat higher than No. 7. Nos. 3 and 6 are quite a little below both Nos. 7 and 8, while Nos. 4 and 5 are considerably higher, as regards fat.

All the foods examined are higher in proteid than No. 8, and all except No. 3 are higher than No. 7, but No. 6, a gluten biscuit is the only one which runs higher than the oatmeal in proteid.

All of the crude fiber determinations run considerably higher than any of the last three in table, No. 1 being more than twice that of No. 8, the highest of the last three.

In carbohydrate content foods Nos. 1 and 8 are practically the same. While No. 2 is a little lower than was 7 or 8, it is higher than No. 9, but No. 3 is higher than any food in the table. No. 6 is lower than any food in the table as regards carbohydrates. However since this last is a diabetic food it should contain less carbohydrates than it does.

Nos. 1 and [illegible] are the same as No. 9 as far as mineral content is concerned. While No. 3 is lower than any other food, Nos. 4 and 5 are very much higher than any other food in the table. No. 6 is higher than 7 but lower than 8 or 9.

In judging of the value of these foods their digestibility must also be taken into account. In order that a comparison may be made between the digestibility of these specially prepared foods and other foods, the results of the artificial digestion of these foods that were examined in this laboratory, and of other foods that were examined elsewhere, are given in the following table.

TABLE NO. 8.

Food No.	Kind of Food.	Nitrogen.		
		In food	In digested residue	Coefficient of Digestibility
1	Malta-Vita	.301	.234	66.90
2	Malt Breakfast Food	.581	.488	84.20
3	Maltex Bread Flour	.292	.239	81.60
4	Horlick's Malted Milk (powdered)	.388	.313	80.10
5	Horlick's Malted Milk (lunch tablets)	.362	.289	80.10
6	Gluten Biscuit	.527	.327	61.03
7	Bread from Standard Patent Flour	.330	.27	82.00
8	Bread from entire Wheat Flour	.340	.26	76.00
9	Bread from graham flour	.340	.20	58.00

The digestibility of Food No. 1 as shown in the above table is much below both Nos. 7 and 8 but is quite a little above No. 7. While Foods Nos. 2, 3, 4, 5 are practically the same as that shown for bread made from standard patent flour, Food No. 6 shows a little lower coefficient of digestibility than No.1 but is still more easily digestible than bread made from graham flour.

The one claim which Malta-Vita makes is that it is thoroughly cooked and predigested, but the low coefficient of digestibility seems not to support this. As far as its chemical composition is concerned it shows it is as good as any ordinary breakfast food.

No. 2 The Malt Breakfast food shows somewhat more nitrogen than the Malta-Vita but is practically the same as far as the chemical composition is concerned, but it has a higher coefficient of digestibility than any food examined or of any of the three samples of bread given in table No. 6. So it would seem that Malt Breakfast Food is all that it claims to be so far as the work done on it shows.

No. 3. This food has a little more protein than the granular corn meal but otherwise is practically the same, as to its chemical composition, and its coefficient of digestibility is fairly high, being about equal to bread made from standard patent flour, so apparently is a good preparation, but judging from the results here obtained it is no better than ordinary flour.

The two samples of Malted Milk, Nos. 4 and 5, have a fairly high protein constituent and also a fairly high coefficient of digestibility. Its claims are principally concerned with it's action on the body, so from this data it is impossible to say whether it is all that is claimed for it or not.

Food No. 6. The protein constituent of this food is not low enough for a gluten food, for the use of diabetics. The part of "10%" referred to in a description of the food probably had reference to the protein, although this cannot be stated definitely. It shows the advantage or disadvantage of labeling products in a way evidently calculated to mislead, and if done deliberately, then no action could be taken. The carbohydrate contents is much too high for a diabetic food and the very low coefficient of digestibility shows how much of the protein present is available. From the chemical analyses and artificial digestion experiments, it would seem best not to recommend Gluten Fischin.

But much more study would be necessary before definite conclusions regarding the value of such products could be reached. However, this study shows the great need of a thorough systematic investigation of the chemical composition, digestibility and nutritive value of so called gluten foods and specially prepared foods.